

CM 681 LC® ALLOY

Cannon-Muskegon has now developed to production status a new high performance integral cast turbine wheel alloy, with the above designation. The alloy was originally developed by CM for the AMSTE initiative (1), as a significant improvement over CM 247 LC® and MAR M 247 alloys, for axial integral cast wheels with fine grain hubs/rims and pseudo DS, columnar grain airfoils. The alloy composition was of necessity specifically designed to be amenable to HIP post-cast processing. During the ASMSTE program integral wheels in CM 681 LC as described above, were successfully subjected to cyclic turbine engine testing known as "go-and-blow" testing. Only in engine operation are the actual rim-to-web thermal gradients achieved during various conditions such as start, acceleration, deceleration and shutdown. The "go-and-blow" test is more severe on the turbine wheel than an actual engine operating cycle (start-run-stop), producing LCF crack growth rates of approximately twice those experienced in actual engine service. Spin pit burst testing of these integral wheels was also undertaken with the normal radial mode bursting at speeds commensurate with the ultimate tensile strength of the material.

LCF testing of CM 681 LC [machined from hub (fine grain + HIP)] (1) shows the alloy is superior to MAR M 247 in the low life, high strain portion of the curve and inferior in the high life, low strain range region. Since the critical portions of integral cast axial wheels tend to operate at high strain ranges, the LCF properties tend to favor CM 681 LC alloy. FCG results [machined from hub (fine grain + HIP)] (1) show CM 681 LC to offer a significant advantage in crack growth resistance compared to MAR M 247 alloy.

The major and minor element chemistry of a 5,000 lb (2.3 tonne) CM Consarc V-6 VIM furnace heat of CM 681 LC alloy is shown in Figure 1. This nickel-base alloy is an oxidation resistant alumina former, with relatively high Ta (6%), low Ti (.2%) and with 3% Re and 1.5% Hf.